destroys the symmetry on either side of the plane of the ring, whilst the dissimilarity of the —H and —CO_2H groups destroys the symmetry about the perpendicular plane. The compound therefore fulfils the fundamental condition for enantiomorphism, namely, that no plane of symmetry shall exist. By way of contrast it may be noted that the compound

$$CH_3\diagdown \diagup CH_2.CH_2 \diagdown \diagup H$$
$$C \qquad\qquad C$$
$$H\diagup \diagdown CH_2.CH_2 \diagup \diagdown CO_2H$$
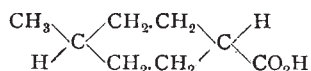
could not exist in enantiomorphous forms or exhibit optical activity, because the four radicles are all situated in a plane (perpendicular to that of the ring) which would thus form a plane of symmetry of the molecule.

Extraordinary difficulties were encountered in effecting the resolution of the acid. Owing to its weak basicity the salts were very ill-defined, and the brucine salt by means of which the resolution was finally accomplished separated from its solutions as an oil which only slowly became crystalline. Again, the brucine salts of the enantiomorphous acids were so similar that an exceedingly tedious process of re-crystallisation was required before they could be obtained with a constant rotatory power, and even then the acids separated from them were not homogeneous, but proved to be capable of further resolution. Evidently the salts are not only similar, but partially isomorphous. Finally, however, both acids were obtained in a pure state, the *l*-acid giving $[a]_D -81.1°$ and the *d*-acid $[a]_D +81.4°$ in absolute alcohol (0.145 gr. in 20 c.c.).

TECHNICAL EDUCATION IN MANCHESTER.

THE sixth annual report of the Manchester Education Committee, dealing with the work of the year 1907–8, has now been published, and provides an excellent example of the way in which an educational authority can build up a complete and duly correlated system of education to meet the precise needs of the area under its charge. The report deals fully with higher, secondary, and elementary education.

The section dealing with higher education is concerned with the year ending in October, 1908, and deals chiefly with technical education. The number of individual day and evening students enrolled at the Municipal School of Technology for the session ending July 31 was 5299, as compared with 5149 for the previous session. The number of individual students enrolled in the day departments was 661, as compared with 651 for the session 1906–7. The class entries for the session were 11,379, against 10,979 for the session 1906–7. These figures do not, however, include the class entries in respect of students in the day departments of the school. Computing the total volume of work of the evening departments in student-hours—that is, by multiplying the number of students enrolled by the total number of hours' instruction given during the session—it was found to be 459,805. The actual volume of work, namely, the total number of hours of instruction multiplied by the actual attendances, was 302,162 student-hours, or 60 per cent. of the total volume of work. Whichever method of computation is adopted, the result obtained shows a marked increase on the previous session.

The imperial grant received year by year increases steadily, amounting during 1906–7 to 9773*l*. The capitation grant paid by the Lancashire County Council in respect of students outside the Manchester area was, for 1907–8, 1226*l*. The Cheshire County Council compounds, so far as its students are concerned, and from this source the school received 400*l*.

It is interesting to notice that a certificate has been instituted this year for students attending the engineering apprentices' course, held on Mondays from 9 a.m. to 6 p.m. throughout the session. To satisfy the conditions of award, students must pass all the prescribed examinations upon completion of the two years' course of study. The certificate has now been awarded to thirty-seven students, who have attended the course during the past four sessions. A similar day course for apprentice painters and decorators has also been inaugurated. The committee of the school has had under consideration the question of extending the facilities to apprentices in other industries for instruction and training during one whole day a week, so as to relieve them from attendance at the evening classes, and at the same time to give additional time and opportunity for homework and study in the evening. After consultation with the Master Plumbers' Association of the Manchester and Salford district, a scheme has been drawn up for apprentice plumbers on the same lines as the course for apprentice engineers.

During the past year opportunity has been taken to improve and develop the organised courses of instruction in several of the evening departments in order more thoroughly to systematise the training given, and to bring the various subjects of the respective evening courses into closer organic relation. The courses in the departments of mechanical engineering, electrical engineering, architecture and builders' work, municipal and sanitary engineering, and textile manufacture, are thus graduated and organised to cover a period of three or five years, leading up to the evening certificate or diploma of the school, as the case may be.

A large number of tests has been carried out during the year for various firms in Manchester and district, and the facilities which the school offers for mechanical and electrical tests, and tests and analyses of a chemical nature, are taken advantage of increasingly, as shown by the fees received, which have increased from 119*l*. in 1904–5 to 319*l*. in 1906–7, and 352*l*. in 1907–8. The members of the staff have been responsible during the session for a considerable amount of original research, a large portion of which has been embodied in papers read before various scientific societies, and published in the journals of the scientific and technical Press.

Not only does the committee govern the Municipal School of Technology, but it aids higher education in other ways. It recommended to the City Council the grant of 4000*l*. received by the Victoria University of Manchester, and is responsible for the grants received from the council by the secondary schools of the district.

ON THE INVENTION OF THE SLIDE RULE.[1]

SOME modern writers attribute the invention of the rectilinear slide rule to Edmund Gunter, others to William Oughtred, but most of them to Edmund Wingate. This disagreement is due mainly to lack of opportunity to consult original sources. It is the purpose of this paper to demonstrate that Wingate never wrote on the slide rule, and that Oughtred is the inventor of the rectilinear as well as the circular type.

It was pointed out by Prof. De Morgan that Gunter invented Gunter's line or scale, but that he did not invent the slide rule. As Gunter's works are found in most large libraries, the correctness of this statement can be readily verified. This scale was not a slide rule, for it had no sliding parts.

No one denies that William Forster published in London in 1632 a book entitled " The Circles of Proportion," which described the circular slide rule invented by William Oughtred. In the dedication it is said that Oughtred invented also the straight-edge type; but this was not described until 1633, when Forster brought out an " Addition unto the Use of the Instrument," with an appendix entitled " The Declaration of the Two Rulers for Calculation," which described the rectilinear slide rule.[2]

The question remains, Did Wingate invent the straight-edge slide rule, and is he entitled to priority over Oughtred? De Morgan maintained that Wingate never wrote on the slide rule,[3] but he had not seen all of Wingate's books. Thus he admits[4] that he had not examined Wingate's " Of Naturall and Artificiall Arithmetique," 1630, yet this very book is quoted by several recent writers as describing the slide rule[5]; but these and all writers who name Wingate as the inventor invariably fail to give

1 Abstract of a paper, by Prof. F. Cajori, read before the Section of Mathematical and Physical Science of the British Association, Winnipeg, August 27.
2 For extracts see Cajori, "History of the Logarithmic Slide Rule." (New York : *Engineering News* Publishing Co., 1909.)
3 " Penny Cyclop.," Art. "Slide Rule," and Wingate, Edmund, " Arithm. Books." Pp. 38, 42. (London, 1847.)
4 " Arithm. Books,' p. 48.
5 A. Favaro in "Veneto Istituto Atti " (5), 5, 1878–9, p. 500 ; Mehmke in " Encyklop. d. Math. Wiss.," vol. i., p. 1054. (Leipzig, 1898–1904.)

evidence which would show that they had actually seen the book to which they refer. We have gathered information about all Wingate's mathematical books which De Morgan did not examine. We shall state where copies can be found, so that the data given here can be verified by those who are near the libraries named. We take up Wingate's books, one after the other, and show that none contains the slide rule.

(1) "L'Usage de la Règle de Proportion," Paris, 1624. De Morgan's assertion that this book describes nothing more than Gunter's scale[1] is corroborated by P. M. N. Benoit,[2] who examined copies in the Bibliothèque nationale and the Bibliothèque Mazarine in Paris. There is a copy in the Bodleian Library.

Wingate brought out in 1626 in London a translation under the title "Use of the Rule of Proportion." Later editions appeared in 1628, 1645, 1658, and 1683. De Morgan saw the 1645 edition, a copy of which is in the British Museum. Wingate died in 1656.

(2) "Arithmétique logarithmique," Paris, 1626. De Morgan described this book.[3] He saw also the "Logarithmeticall Table," London, 1635, which is anonymous, but is attributed to Wingate.[4]

(3) "Construction and Use of the Line of Proportion," London, 1628. Copy in the British Museum. The "line of proportion" here described is merely a mechanical table of logarithms. There are no sliding parts.

(4) "Of Naturall and Artificiall Arithmetique," London, 1630. Copy in the Bodleian Library. Describes only the instrument named in the preceding text. The first part of this book was enlarged by John Kersey the elder in 1650 under the new title "Arithmetique Made Easie." De Morgan saw the editions of 1673 and 1760.[5] The second part was re-edited by Wingate in 1652. Copy in the British Museum. The instrument described here is still the "line of proportion."

(5) "Ludus Mathematicus," London, 1654, 1681. De Morgan[6] inspected the first edition.

(6) "Use of the Gauge-rod," London, 1658 (second edition).

(7) "The Clarks Tutor for Arithmetick and Writing . . . being the Remains of Edmund Wingate," London, 1671. Copies of both books in the Bodleian Library. Neither contains an account of the slide rule.

MASONRY ARCHES.

A MEMOIR dealing with a subject of great interest to the engineer has recently been issued as a Drapers' Company Research Memoir.[1] It must be admitted that the ordinary treatment of the masonry arch is by no means satisfactory, and therefore any solution of the problem which would give more accurate and trustworthy results without involving excessive labour in the necessary calculations would be welcomed by every engineer who may in the course of his professional duties have to deal with the design and erection of masonry or brick arches.

After discussing the ideal arches for different load conditions, the authors show that for the fairly flat arches of modern practice designed to carry (1) a uniform load per foot run of the rib, or (2) a vertical load rising to a horizontal at a height $l^2/8r + r/6$ above the central line at the crown, the elliptic arch is the proper design.

The rest of the memoir is devoted to an investigation of the extent of the applicability of the elliptic arch. It is shown that for the loads usual in masonry arches the elliptic arch is only closely approximate to the ideal if the ratio of rise to span be small, this latter condition involving large horizontal thrusts and great compressive stresses.

The authors then show that a close approximation to the arch the line of pressure of which coincides with its central line can be obtained with no great labour of calculation, and such an arch they term a pseudo-elliptic arch.

1 "Arith. Books," p. 42.
2 "La Règle à Calcul expliquée," p. vi. (Paris, 1853.)
3 "Penny Cyclop.," Art. "Tables," p. 497.   4 *Loc. cit.*, p. 498.
5 "Arith. Books," pp. 48, 73.   6 *Op. cit.*, p. 44.
7 "On a Practical Theory of Elliptic and Pseudo-elliptic Arches, with Special Reference to the Ideal Masonry Arch." By Prof. Karl Pearson, W. D. Reynolds, and W. F. Stanton. Pp. 23+6 plates. Drapers' Company Research Memoirs, Technical Series, VI. (London: Dulau and Co., 1909.) Price 4s.

The necessary equations to give the required solution are obtained, and an example is worked out in detail to show the application of the method and to prove that the labour of the necessary calculation is not a serious obstacle to the employment of this method. The memoir is illustrated by six plates reproduced from actual drawings.

The applied mathematics department of University College is to be congratulated on this valuable addition to the series of research memoirs dealing with difficult engineering problems for which Prof. Karl Pearson and his students have been responsible.   T. H. B.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GRADUATES of the late Royal University of Ireland who desire to be registered as graduates of the Queen's University of Belfast, or enrolled as members of Convocation, should communicate as early as possible with the secretary of the latter University. The first meeting of Convocation must be held within the next four months.

WE learn from *Science* that, according to figures available in the office of the auditor, the University of Chicago holds investments representing permanent endowment that amount to 2,974,000*l*. In addition, its buildings and grounds devoted entirely to university use represent 1,783,540*l*.; equipment, scientific apparatus, furniture, &c., being put at 383,260*l*. additional. These figures do not include the funds destined for the erection of the Harper Memorial Library, estimated in round figures to cost 180,000*l*., nor the cost of the classical building, the construction of which is in contemplation, and on which about 50,000*l*. will be expended.

DR. CHARLES GRAHAM, at one time professor of chemistry at University College, London, and a prominent member of the Society of Chemical Industry, who died on November 13, has left the residue of his estate for medical research. The amount available will probably be 35,000*l*., and it is left to the Senate of the University of London to found a fund, to be known as the Charles Graham Medical Research Fund. The fund is to be applied in aid of any research carried on by a teacher or student of the school of advanced medical studies of the University College Hospital for the prevention, cure, or alleviation of human disease or suffering. If any student or teacher conducts a research which is considered of sufficient merit a gold medal of appropriate value is to be awarded to him. The committee of the school is also to pay to such teacher or student conducting the research an annual sum not exceeding 200*l*. per annum for two years, such person to be known as the "Charles Graham Student in Pathology."

THE Department of Agriculture and Technical Instruction for Ireland has issued a syllabus (Circular 70) of the examination which it proposes to hold in the principles, methods, and history of education, with special reference to science teaching. The examination will be held in June of each year. The examination is provided for candidates seeking recognition of qualification to teach science. Among the subjects included in the syllabus are:—The general characteristics of the curriculum and methods of instruction in science as determined by the laws of general development; the correlation of science with other subjects of the curriculum. The methodology of instruction in science as determined by the laws of development of knowledge; the functions and relations of laboratory work and class-teaching. The critical study of the history of a special branch of science so far as it bears upon the teaching of the subject. The use of note-books and text-books in science teaching; methods of recording and treating observational data. The construction and use of pictorial illustrations, diagrams, and models; the construction of apparatus. Laboratory organisation and management.

THE "Regulations for Secondary Schools" of the Board of Education lays it down that in all fee-charging secondary schools free places must be offered, under certain conditions, at the beginning of each school year to pupils entering from public elementary schools. The number of such places offered must ordinarily be 25 per cent. of the total number of pupils admitted to the school during the previous